FUMAROLE AND CRATER LAKE MONITORING AT POÁS VOLCANO, COSTA RICA

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Introduction:

Poás volcano (10°12'00"N, 84°13'58"W, 2708 m) is one of the most active volcanoes of Costa Rica. Two vents were active at Poás' main crater during the 1952-1955 eruptive cycle: one that formed a small composite pyroclastic cone, 40 m high that was formed in the central part of the active crater, and another unnamed vent that was formed 150 m to the north of the pyroclastic cone. The northern vent collapsed and later filled with water to form Laguna Caliente. The current crater shows steep walls containing abundant pyroclastic deposits issued through the crater lake and some massive lavas.

Accessibility and Sampling:

Poás National Park is located approximately 35 km northwest of San José, in the Central Volcanic Range of Costa Rica, about one hour and an half drive by a paved road. Poás is located at the continental. divide, influenced by both Caribbean and Pacific weather conditions. The driest months go from February to May. The rainy months go from June to January. A low cloudbase is persistent during the rainy months with temperatures, at the summit, ranging from 12°C to 20°C.

All of Poás activity takes place within the active crater (1131 m wide, 320 m deep, Fig. 1). The bottom of the crater is reached after a hike of 30 minutes to one hour (route depending) walking down a trail through steep walls. Laguna Caliente (Fig. 1, a) can be easily sampled along the E and NE shore while fumaroles on the pyroclastic cone are accessible only when such activity is not very vigorous (average temperatures at present are in the ~90°C, although temperatures above 180°C were measured last year). The most vigorous fumaroles located on the north side of this cone are not available for sampling at the moment given their location on a vertical wall that falls (40m) directly into the acid lake. The fumaroles located south of the cone (Fig.1, b) and at the base of its south side, can be sampled safely, as well as that one east of the cone (Fig.1, e). Their temperature ranges from 90°C to 93°C.

Fumarolic Activity:

Poás activity, reported since 1828, shows almost constant fumarolic activity (very mild to very intense) with geyser like phreatic events in which hot water, vapor, mud and blocks are emitted. Also, phreatic eruption events have occurred when non-juvenile materials are

erupted (i.e. 1994). A fumarole field (c,b) that changes in intensity and location within the active crater over time is consistent with a shallow magma body that is constantly degassing and periodically intruding the upper portion of the conduit (Rymer et al. 1998). The two vents that were active during the strombolian activity of 1953-1955 have been the locus of the more intense fumarolic activity at Poás' main crater since 1955. Events of intense fumarolic activity occurred within the last two decades (1981-85, 1987, 1990, 1994 and 1999).

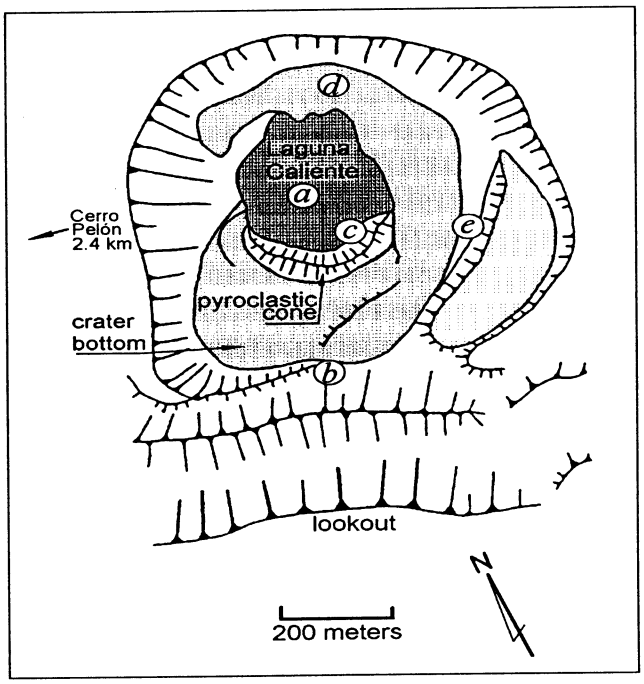

Figure 1. Map of the main crater of Poás Volcano. From January 1993 to May 1995, subaqueous fumarolic activity predominated at Laguna Caliente (a). Then the main fumarolic activity migrated to the southern wal.l of the crater in May, 1995 (b). Finally, after January 1996, the locus of most fumarolic activity was centered on the pyroclastic cone (c). Fumaroles, formed on a NE trending fracture, on the northern terrace, (d). The east fumaroles appeared at the end of 1999 (e).Cerro Pelón is part of a dead zone due to acidic deposition. Map from Martínez et al.. 2000.

Fumarolic activity at Poás has been switching sites from the pyroclastic cone to beneath the lake and viceversa at least twice during the last three decades. In addition, after 1995 fumaroles started to open, away from the 1950's active vents (fig.1 d,f y e) inside Poás' main crater. Intermittent hot springs appeared east of Laguna Caliente from 1999 to present with temperatures ranging from 30°C to boiling point.

Poás plume and acid deposition impact:

Poás volcanic plume is a combination of two processes related to volcano degassing: Subaerial fumaroles from the pyroclastic cone, and lake evaporation which generate vapors rich in hydrochloric and sulphuric acids. A volcanic plume rises permanently from the bottom of the crater. The height of the plume changes with time, so from 1993 to 1997 ranged from 100 m to

500 m while during the phreatic event in mid-1994 the plume reached 1600 m (Martínez et al. 2000). Such plume is transported by the prevailing winds to the SW and W, rarely in other directions of the volcano, where more than 20 000 people reside in small villages and farms. The acid deposition impacts their health, crops and infrastructure up to 10 km downwind from the volcano.

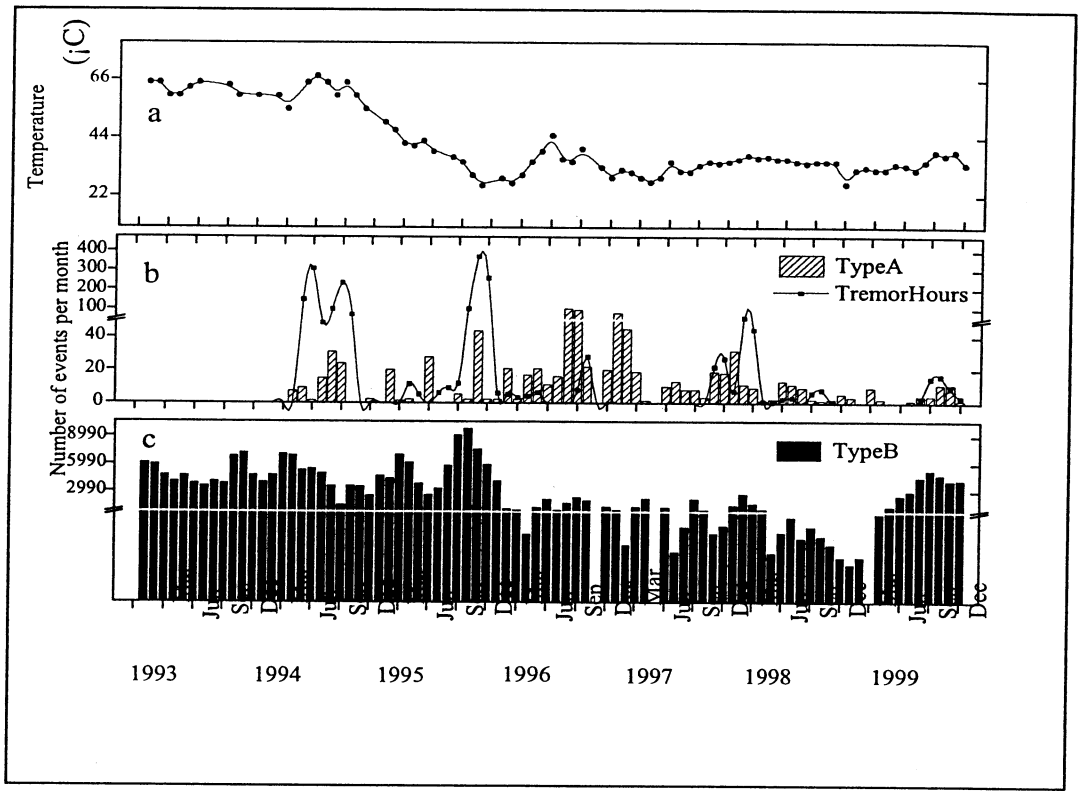

Figure 2. Monthly variation of physical. parameters related to Laguna Caliente (1993-1999). (a) crater lake water temperature; (b) summit seismicity recorded at POA2 seismographic station: Type A seismicity and tremor hours, and (c) Type B seismicity.

Crater Lake Monitoring:

The geochemical properties of Laguna Caliente, as well as variations in its temperature, volume, depth, seismicity and plume height, reflect both climatic effects and interactions with a shallow subsurface magma body and associated magmatic-hydrothermal. system (fig. 2 b,c). Martínez et al. (2000) extensively dealed with chemical. variations with time of crater lake water, showing a relationship between periods of subaqueos fumarolic discharge and changes in lake water chemistry. In terms of acidity, pH ranges from <0 to ~2 (fig. 2 and 3) Temperature has ranged from 25°C to 70°C currently being 39°C.

The crater lake is filled with a concentrated chloride-sulphate brine rich in rock-forming elements and fine native sulphur particles. According to the physico-chemical. classification scheme for volcanic lakes of Pasternack and Varekamp (1997) Laguna Caliente was a hot acid hyperbrine volcanic lake from 1984 to 1994 when the focus of subsurface magmatic-hydrothermal activity

was beneath the lake. The chemistry of the lake changed gradually to an acidic-saline brine between 1996-2000 when the activity migrated back to the cone. Despite this migration, some fumaroles are, nowadays, visible from the crater lake surface as effervescent zones. The concentrations of dissolved chloride and sulphate ions in the crater lake water from 1994 to present are one order of magnitude smaller compared to samples collected prior to the disappearance of the lake when these concentrations were near 80 000 mg/L. Presently lower ions concentrations in the lake are due to a decrease in fumarolic activity, and to an increase on its volume (Martínez et al. 2000).

Gas Monitoring:

Volcanic gases and gas condensates have been monitored for more than two decades at their source and downwind from the active crater. Fumarole gas composition (in % by vol.) has been assessed for several gases since 1997: SO_2 ranges from 0 to 3,4%, while CO_2 and H_2S stay in the order of 0 % by vol. The fumaroles and springs sampled do not show much temperature changes with time, nonetheless, there are important chemical changes. Slight decreases in HCl and slight increases in the concentrations of the other gases suggest dilution and oxidation processes due to aquifer interaction with a magma body (Vaselli et al., 2000).

Since July 1999 concentrations of dissolved gases such as SO_2 and H_2S have been monitored using gas sensing tubes (Drager tubes). The observed concentration variations of SO_2 and H_2S dissolved in the lake water between 1999-2000, are interpreted in the context of changes occurred in the crater lake as a result of the changes on the outgassing of the shallow magma body of Poás Volcano during this period. The monitoring of these parameters are of high relevance for our volcano watching program since changes in the amounts of SO_2 and H_2S released have been considered precursors of phreatic eruptions in other crater lakes (Takano et al. 1987). Also COSPEC measurements estimated SO_2 in 700 ±180 tons per day (Casadevall et al. 1984).

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